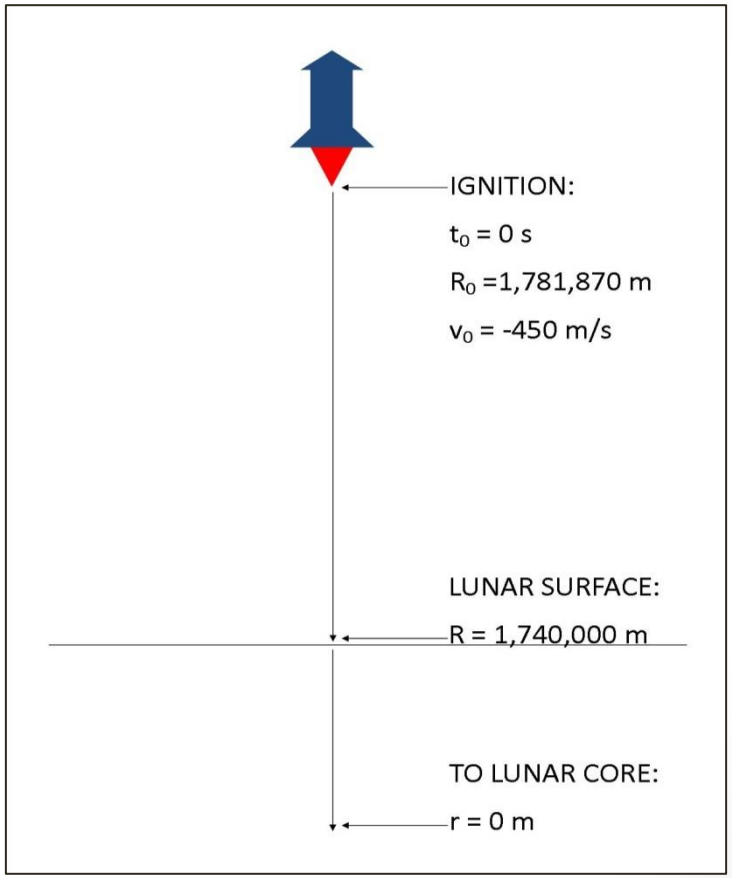
Predicting Landing Solutions for a Rocket in a Two-Body System

Spring 2014 · Honors

Professor Thorp · C++

Overview & The Model

- Conduct a parameter study to:
  - identify the relationships between parameters in a mathematical model.
  - Investigate the reliability of curve fitting numerical landing solutions from the model (e.g. y=f(x)).



Edwards, C. Henry, and David E. Penney. *Differential Equations & Boundary Value Problems Computing and Modeling*. 4th ed. Upper Saddle River: Pearson Custom, 2008. Print.

Numerical Methods & C++

- Advantages of numerical methods:
  - Provide an alternative for solving non-linear ODEs.
  - Easily implemented as a computer program.
  - Commonly found in industry (aerospace & finance).
- Our numerical methods:
  - The Euler method
  - 4^{th} Order Runge-Kutta.
- Using the C++ programming language we:
  - Added additional code to handle systems of equations.
  - Reduced trial times and human input error.

Case Study & Parameter Study

- Case Study
  - Used a 2nd order non-linear ODE.
  - Validated the RK4 integrator using the expected case study values.
- Parameter Study
  - Collected 21 data points.
  - Plotted the points and applied a quadratic fit to the data set using Microsoft Excel.
  - Interpolated 6 points and extrapolated 8 points.
  - Drew conclusions based on metrics such as percent error.
  - Extrapolated using different curve fits.

Results & Future Investigations

- Identified the conditions needed to obtain reliable curve fits.
- This technique can be used for non-aerospace models.
- Our project received positive feedback from academia and industry.

Future Investigations

- Implement more complex numerical methods.
- Develop a more complex aerospace model by introducing the following parameters.
  - Drag using standard atmosphere data at multiple altitudes.
  - Mass reduction due to fuel burn.
  - Drag and mass reduction from rocket staging.